TF 2431

200 MHz Digital Frequency Meter

INSTRUCTION MANUAL

MARCONI INSTRUMENTS

Supplement No. H 54811-002V

SAFETY PRECAUTIONS

- For inclusion in instruction manuals for mains operated equipment -

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, set the equipment supply switch to ON.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous.

Fuses

Note that the supply fuse is connected in series with the brown (live) wire of the supply lead. If the equipment is connected to the supply via a two-pin plug, it will be possible for the fuse to become connected to the neutral side depending upon the orientation of the plug in its socket. In these circumstances certain parts of the instrument could remain at supply potential even after the fuse has ruptured.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

Instruction Manual
No. H 52431-900T
for

200 MHz Digital Frequency Meter

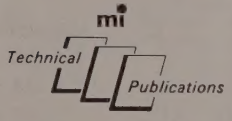
TF 2431

Code Nos. 52431-301Y and 52431-302N

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of EEC Directive 76/889 as to limits of r.f. interference.

H 54881-030D:C1



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Chapter 1

General information

1.1 INTRODUCTION

TF 2431 is a general purpose instrument suitable for measuring the frequency of signals in the band 10 Hz to 200 MHz. Its versatile input buffer and amplifier incorporating a.g.c. has a high tolerance of signal distortion and noise and ensures reliable operation over a wide dynamic range of input levels without the need for a manual control.

The counter has a bright 8-digit 7-segment l.e.d. display with memory, automatic position of decimal point, leading zero suppression and active indication of overflow, hold and external standard operation. Push button switches select the resolution required, the maximum being 0.1 Hz over the entire frequency range.

Gate times are derived from an internal 10 MHz crystal oscillator or from an external standard if required. The high-stability alternative version of the instrument, Code No. 52431-302N, is fitted with an oven-controlled internal 10 MHz standard.

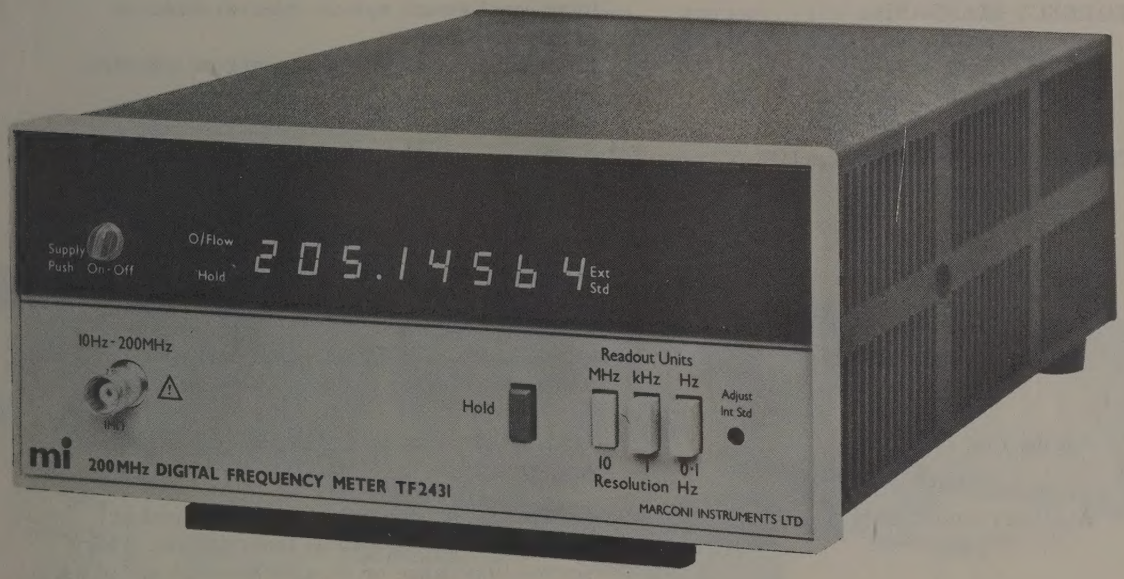


Fig. 1.1 200 MHz Digital Frequency Meter TF 2431

1.2 DATA SUMMARY

FREQUENCY RANGE :	10 Hz to 200 MHz.
SENSITIVITY :	10 mV r.m.s. sine wave. Built-in a.g.c. provides capability for handling signals over a dynamic range of up to 90 dB automatically.
MAXIMUM INPUT :	260 V r.m.s. at 50 Hz (sine wave), 5 V r.m.s. at 200 MHz (sine wave). Maximum d.c. : 250 V. Maximum a.c. + d.c. : 250 V r.m.s. at nominal 50 Hz, decreasing from 50 Hz to 200 MHz by approx. 1.3×10^{-6} V/Hz.

INPUT IMPEDANCE :	Approx. 1 MΩ in parallel with less than 25 pF. AC coupled via 0.1 μF.
DISPLAY :	8 digits with memory. (7 segment l.e.d. of 7 mm minimum height).
Units and resolution :	Three push buttons select gate times providing resolutions of 10, 1 or 0.1 Hz and indicate readout units. Decimal point automatically selected. Hold indication. Overflow indication. Leading zeros suppressed.
Display time :	Readout retained during gating period or held indefinitely by means of HOLD button.
ACCURACY :	±1 count ± stability of frequency standard.
FREQUENCY STANDARD :	Rear panel switch selects internal standard or external input. Front panel indication when external standard selected.

INTERNAL CRYSTAL OSCILLATOR (Version 52431-301Y)

Frequency :	10 MHz.
Adjustment range :	Compensation for ageing drift may be made by a front panel preset.
Temperature stability :	Within ±5 parts in 10^6 over the operating temperature range of the instrument.
Ageing rate :	Approx. ±2 parts in 10^9 per day at a constant temperature.
Auxiliary output level :	Internal standard available at rear panel at approx. 4 V pk-pk e.m.f. from approx. 2 kΩ source impedance or greater than 100 mV pk-pk into 50 Ω.

INTERNAL CRYSTAL OSCILLATOR (Version 52431-302N)

Frequency :	10 MHz.
Adjustment range :	Compensation for ageing drift may be made by a front panel preset.
Temperature stability :	Within ±1 part in 10^7 over the operating temperature range of the instrument.
Ageing rate :	Within ±1 part in 10^7 per week after 1 month continuous use.
Auxiliary output level :	Internal standard available at rear panel at approx. 4 V pk-pk e.m.f. from approx. 2 kΩ source impedance or greater than 100 mV pk-pk into 50 Ω.

EXTERNAL INPUT

Frequency :	10 MHz (sine or square wave).
Input level :	2.5 V to 5.5 V pk-pk.
Input impedance :	Approx. 300 Ω, a.c. coupled.

OPERATING TEMPERATURE RANGE : 0 to 40°C.

POWER REQUIREMENTS :

AC mains :	95 to 130 V (115 V nominal), 190 to 264 V (230 V nominal).
Frequency :	45 to 500 Hz.
Consumption :	10 VA approx.

DIMENSIONS AND WEIGHT :

Height	Width	Depth	Weight
100 mm (4 in)	220 mm (8 3/4 in)	310 mm (12 in)	2.2 kg (4 3/4 lb)

1.3 VERSIONS AND ACCESSORIES

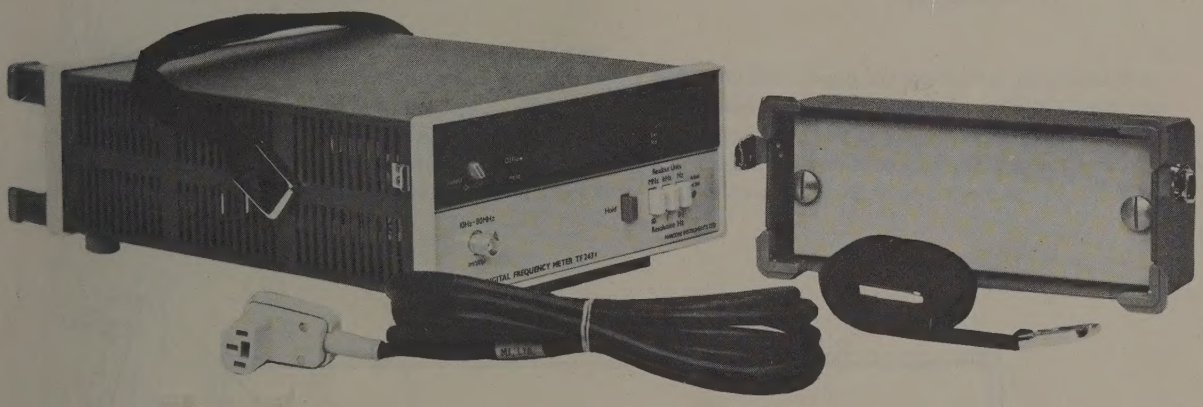


Fig. 1.2 Instrument complete with accessory kit

Versions	MI Code
Standard version	52431-301Y
Alternative version with high stability internal frequency standard	52431-302N
Supplied accessories	
Mains lead (detachable)	43123-076Y

Optional accessories	MI Code
Accessory kit comprising :-	46883-281N
Stowage lid Rear stand Hand strap Shoulder strap Right angle entry mains lead	
Rack mounting tray	46883-282L
Coaxial lead, 1 m long, with BNC plug at each end	43126-013W

Chapter 2

Operation

2.1 INSTALLATION

The instrument is supplied ready for bench mounting but a rack mounting tray is available as an accessory. This consists of a housing with two compartments either of which will accommodate a TF 2430/1 without its case. The other compartment is covered with a blank panel or can be used to house a second TF 2431 or similarly sized instrument. Full fitting instructions are supplied with the tray.

The mains lead supplied is a free cable fitted at one end with a socket that connects with the 3-pin plug at the rear of the instrument. When fitting a mains plug to the lead make sure the following colour coding is observed :-

Live	-	Brown
Neutral	-	Blue
Earth	-	Green/Yellow

Before connecting the instrument to the power supply, check that the AC SUPPLY switch at the rear is correctly set and that the corresponding value of fuse is fitted. The instrument is normally despatched with the switch set to 230 V, i.e. for operation from 190 to 264 V supplies. To change to the 95 to 130 V supply range remove the switch locking plate, switch to 110 V and refit the plate to suit. Note that the fuse must also be changed to the rating indicated beside the switch.

2.2 CONTROLS AND CONNECTORS

Front panel

(1) SUPPLY switch - Turn clockwise to switch on. The display will illuminate when supply is on.

(2) INPUT socket - 50 Ω BNC connector.

⚠ CAUTION : Do not exceed the maximum a.c. or d.c. input levels stated in Sect. 1.2 Data summary.

(3) HOLD - Push button action prevents the memory being updated. This allows the display to be retained indefinitely even if the input is removed. Push again to release and allow updating of the memory to continue.

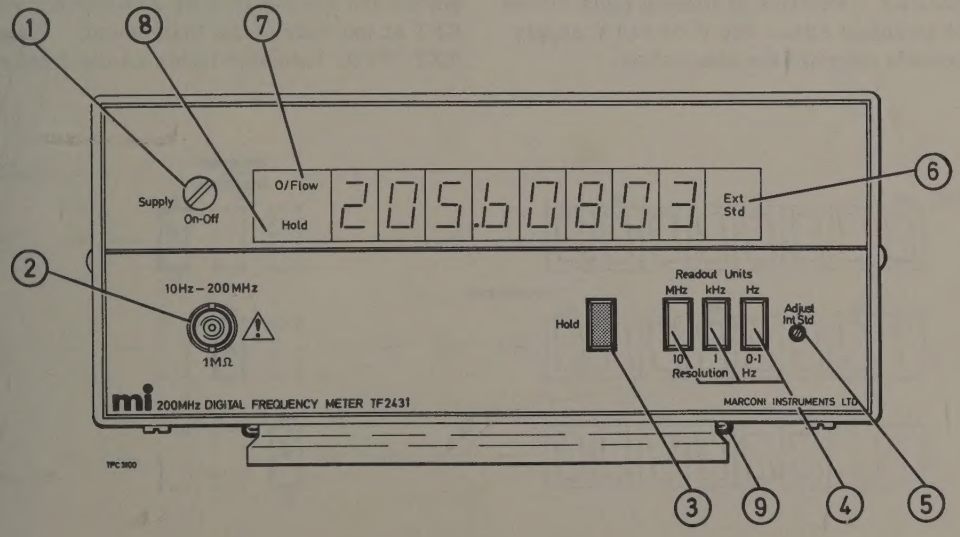


Fig. 2.1 Front panel controls and connectors

④ READOUT UNITS - Three interlocking push buttons select gate time hence resolution and decimal point position.

⑤ ADJ.INT.STD. - A screwdriver adjustable trimmer with 10 turns allows fine adjustment of the internal frequency standard (see Sect. 4.5).

⑥ EXT.STD. indicator - Shows that rear panel 10 MHz STANDARD - EXT has been selected.

⑦ O/FLOW indicator - Shows that the most significant digit or digits have overflowed the display.

⑧ HOLD indicator - Shows that HOLD button has been engaged.

⑨ SUPPORT - Hinges down to raise the front of the instrument.

Rear panel

10 MHz STANDARD - INT selects internal frequency standard whose output is then available at the OUT socket (50 Ω BNC).

EXT selects external frequency standard which must then be applied to the IN socket (50 Ω BNC).

⚠ CAUTION : Do not exceed 5.5 V pk-pk at the EXT IN socket.

AC SUPPLY - Position of locking plate allows switch to select either 230 V or 110 V supply and reveals appropriate fuse rating.

2.3 FREQUENCY MEASUREMENT

(1) Connect the signal to be measured to the input socket.

(2) Select the internal or external frequency standard by means of the 10 MHz STANDARD INT/EXT switch at the rear of the instrument. The front panel indicator lights if EXT.STD. is selected.

(3) Select the required READOUT UNITS, noting the corresponding resolution figure, i.e. the value of the smallest units in the display. The decimal point position, readout calibration and gate and display times are shown in Fig. 2.2.

(4) If the resolution selected results in a display of more than 8 digits the overflow indicator illuminates and the most significant digits are 'lost'.

The display will be updated at the intervals shown in Fig. 2.2 unless the HOLD button is pressed. In this case the HOLD indicator will light and the display will be held indefinitely, even if the input signal is removed.

2.4 USE OF EXTERNAL STANDARD

As an alternative to using the internal crystal standard to provide the gating an external standard of 10 MHz may be used. Connect the external standard to the 10 MHz STANDARD IN socket and set the 10 MHz STANDARD switch to EXT at the rear of the instrument. Note that the EXT. STD. indicator lights on the front panel.

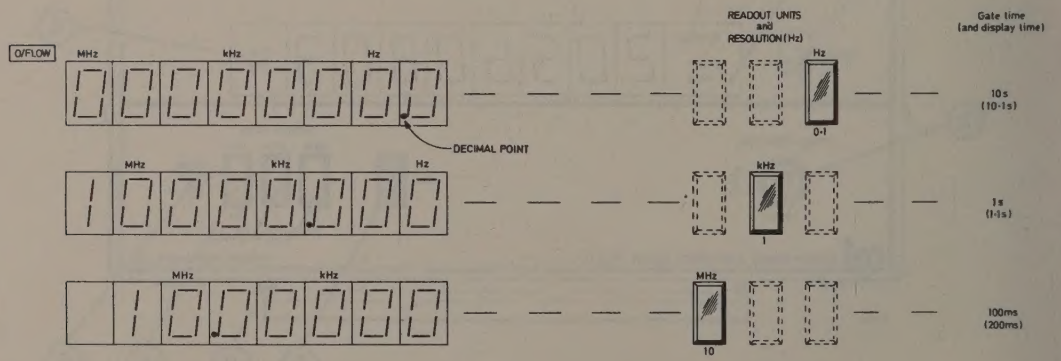


Fig. 2.2 Readout calibration and display data for a 10 MHz signal

2.5 SELF CHECK PROCEDURE

A simple test to show that the instrument is working correctly can be performed by using it to measure its own standard output. This does not, of course, verify the accuracy of indication since any error in the standard will be cancelled by a corresponding error in the gating time which is derived from the same source.

To do the test proceed as follows :

(1) Connect the 10 MHz STANDARD OUT socket to the INPUT socket and terminate the signal into 50 Ω by using a T-connector.

(2) Set the 10 MHz STANDARD switch to INT.

(3) Select each of the READOUT UNITS in turn and check that the readout is within ±1 count of that shown in Fig. 2.2.

(4) Press the HOLD button and check that the HOLD indicator lights and that the readout is retained when the input lead is disconnected.

Chapter 3

Technical description

3.1 INPUT AMPLIFIER, GATE AND HIGH SPEED DECADES

The input signal is fed into an input buffer comprising a dual gate m.o.s. f.e.t. and emitter follower whose gain and, for high level signals, attenuation can be controlled by a d.c. voltage applied to the m.o.s. f.e.t. The output of the subsequent wide band amplifier is detected and converted into a proportional d.c. voltage which controls the buffer.

The output signal from this wide band amplifier is of constant amplitude and its level just exceeds the hysteresis window of the Schmitt trigger, thus ensuring reliable triggering even when the signal has a poor signal-to-noise ratio. The square wave from the Schmitt trigger is applied to one input of an i.c. gate and is gated by a signal whose duration is precisely controlled. The pulse train from the main gate is counted by an eight decade counter, two and a half decades of which are discrete i.c.'s and the remainder part of a custom designed l.s.i. m.o.s. i.c.

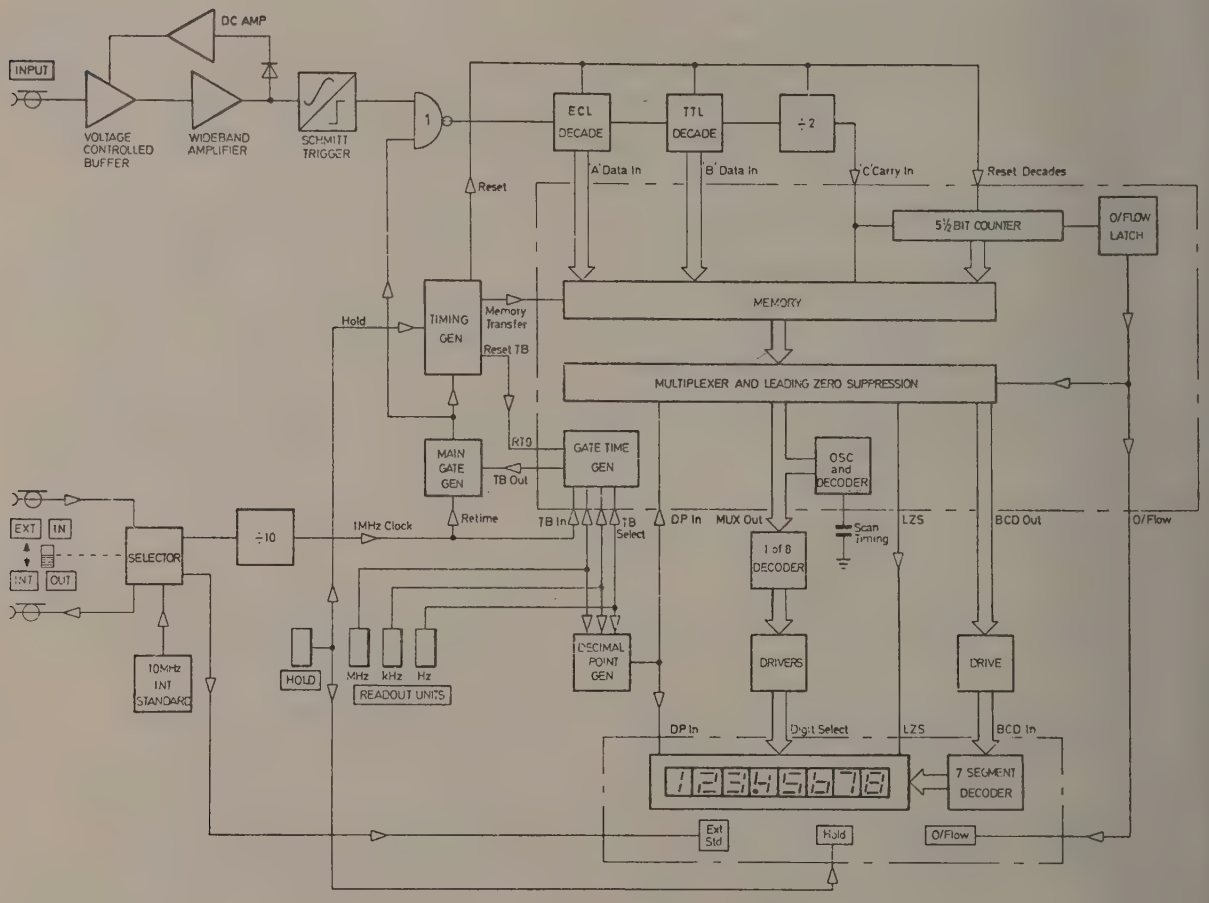


Fig. 3.1 Block diagram

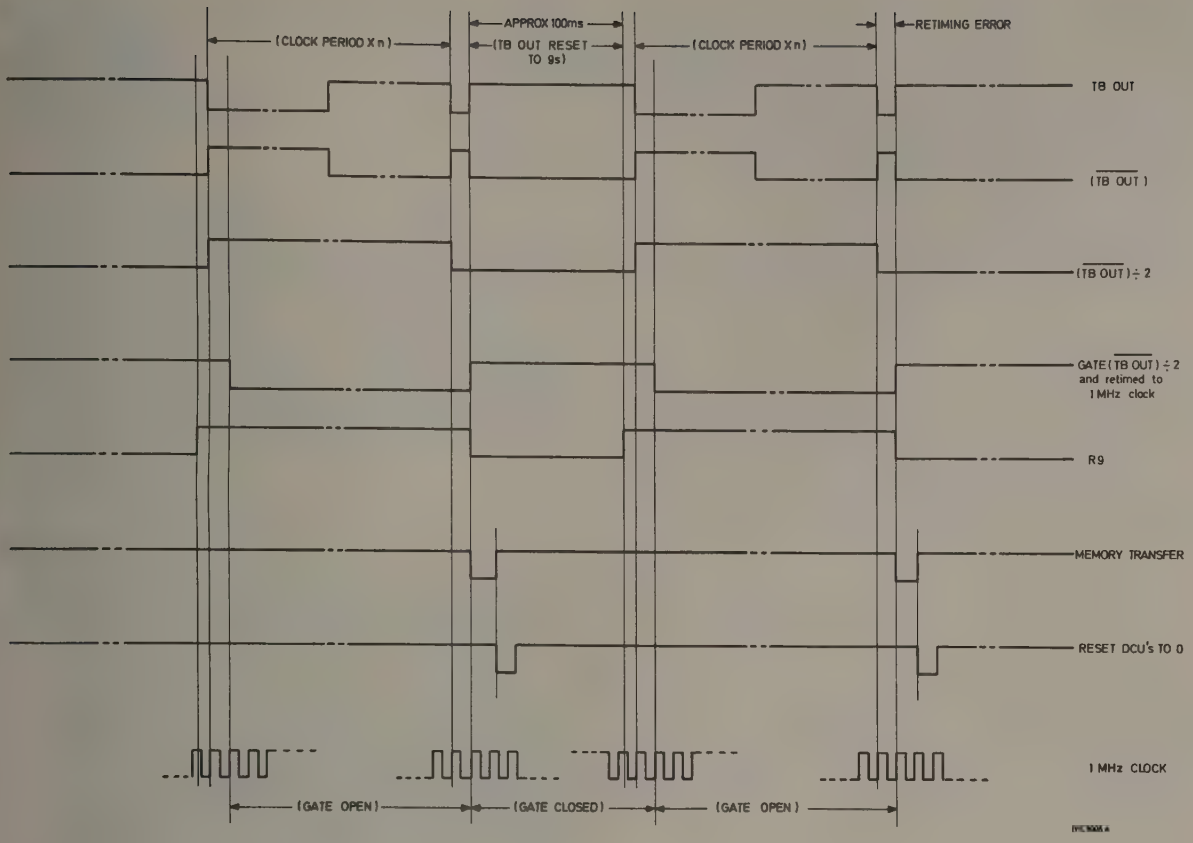


Fig. 3.2 Timing sequence

3.2 CLOCK SELECTION AND GATE GENERATOR

The counter's main reference clock can be generated from an internal crystal oscillator or introduced from an external 10 MHz source via the EXT STD IN socket.

Before being used to generate the gating signal or to retime the main gate the 10 MHz signal is divided by 10. This 1 MHz clock is fed into the m.o.s. i.c. and divided down by the selected ratio, the maximum being 10^7.

The time base output is divided by two and retimed with the original 1 MHz clock signal before being applied to the main gate.

3.3 TIMING GENERATOR

TTL monostable integrated circuits generate a timing sequence which describes the display time, memory transfer and reset times. Waveform diagrams which show the timing sequences are illustrated in Fig. 3.2.

3.4 LOGIC CIRCUIT

A custom designed l.s.i. m.o.s. integrated circuit is the heart of the counter and contains all the digital logic that does not need to run at high currents or speeds.

The i.c. contains a $5\frac{1}{2}$ decade counter with overflow latch and an eight decade memory. Two and a half decades of the memory have a parallel data loading capability to enable the i.c. to be used with higher speed logic.

The data from the memories are fed into a multiplexer which is controlled by an on-chip oscillator and 1 of 8 encoder. A signal for providing leading zero suppression is generated in the i.c. The 40 pin package also contains a time base section comprising a seven decade divider and a 1 of 7 data selector.

3.5 SWITCHING

Front panel controls select HOLD and one of three gate times. The 100 ms, 1 s or 10 s gates describe the display resolution, units and decimal point position.

3.6 DISPLAY BOARD

The display board contains the 7 segment l.e.d. displays and b.c.d. to 7 segment encoder with its associated current limiting resistors. The board requires 1 of n digit drive (where n = number of displays), multiplexed b.c.d. information, a decimal point signal and leading zero suppression signal. Three lamps are mounted on this board indicating HOLD, OVERFLOW and EXTERNAL STANDARD operation.

Chapter 4

Maintenance

4.1 GENERAL

This section is intended as a general guide to the servicing of the instrument. In case of difficulties that cannot be resolved with the aid of this book, or for advice on maintaining the instrument, please write or phone our Service Division or nearest Area Office or Agent. Always mention the type number or serial number of your instrument. (Address on rear cover.)

The only part of the instrument which should need regular attention is the 10 MHz oscillator. This should be periodically checked to ensure that it is operating at the correct frequency, and adjusted to offset any ageing drift that has taken place.

CAUTION Static sensitive components

Components identified with the symbol ⚠ on the circuit diagrams and/or parts list are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

4.2 FUSES

The counter is protected by a delay fuse (FS1) in the line conductor of the mains supply. The instrument should be turned off while the fuse is changed. Access is by means of a screw cap on the rear panel.

4.3 REMOVING COVERS

The cover is retained by two screws at the back of the instrument. These screws also hold the protective clamps and their removal allows the case to be slid backwards over the rear panel. The separation of instrument and case is best achieved with the instrument upside down.

4.4 ACCESS TO POWER SUPPLY

The function board and transformer support chassis are held between the two side frames of the uncased instrument.

Power supply components are below the chassis and access to them can be gained by hinging the chassis forward into a vertical position. This is done by removing the two chassis retaining screws on the rear panel and the rear two screws holding the chassis to the side frames. The remaining side frame screws should then be slackened, so that the chassis may hinge about them, and tightened to hold it in a convenient position. No electrical connections need to be removed.

4.5 ADJUSTMENT OF INTERNAL 10 MHz STANDARD

The accuracy of the internal standard can be checked by comparing it with an accurately known external standard as follows :-

(1) Set the 10 MHz STANDARD switch to INT.

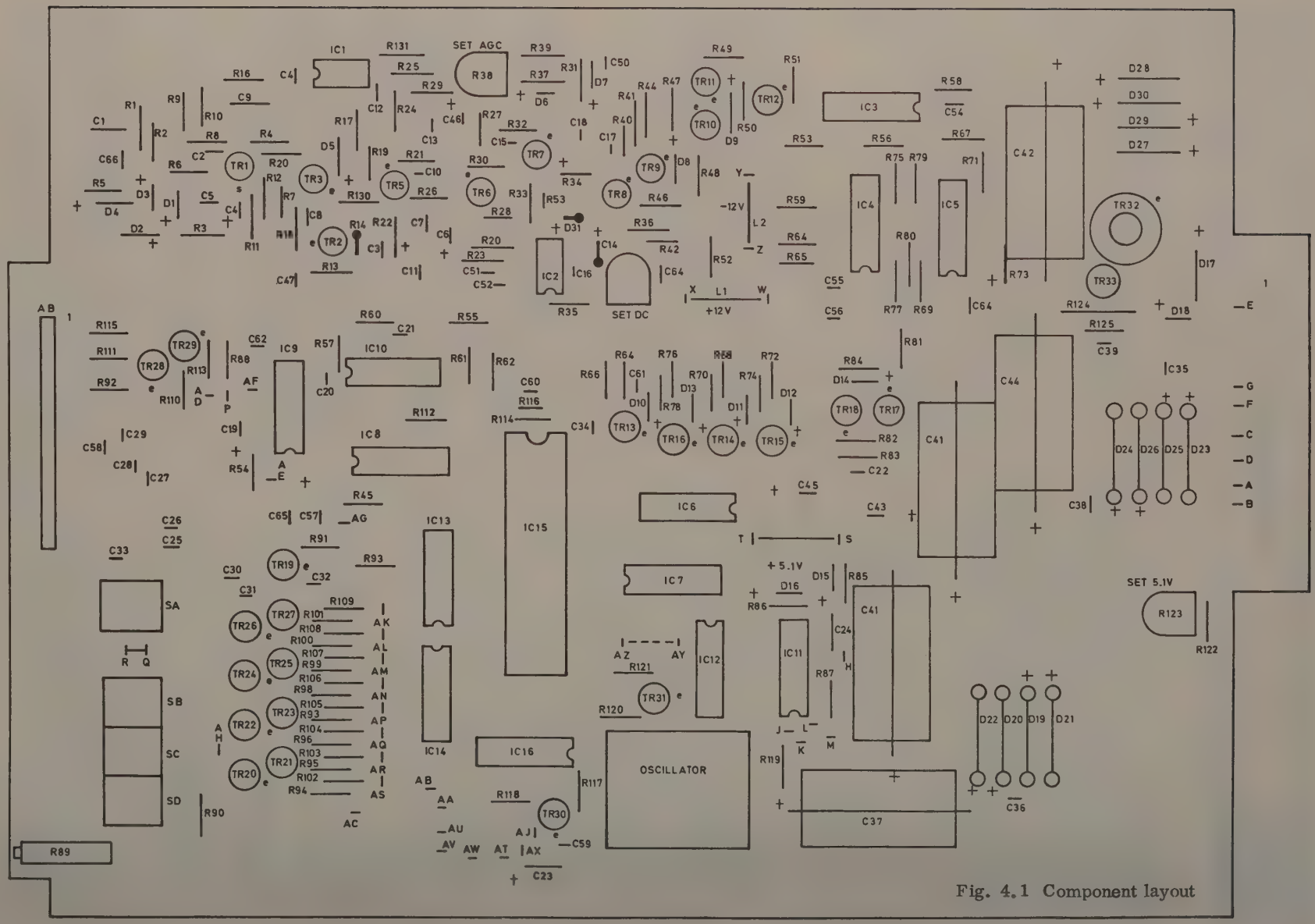


Fig. 4.1 Component layout

(2) Connect a known external frequency to the INPUT socket. The value of the frequency is unimportant, although higher frequency allows greater discrimination.

(3) If necessary fine adjustment of the internal standard can be done, without removing the instrument from its case, by means of the ADJ.INT.STD. facility on the front panel.

If the internal standard cannot be set accurately with the ADJ.INT.STD., coarse adjustment to the oscillator frequency can be carried out by means of a preset variable capacitor (A3C2 or A4C2). Access to this is obtained by removal of the instrument case.

4.6 ACCESS TO DISPLAY BOARD

The display board is mounted in a 20-way edge connector at the front of the instrument. It contains eight 7-segment numeric displays, 3 discrete lamps and a b.c.d. to 7-segment decoder. The board can be removed by lightly pushing the top edge away from the front panel, until the retaining bushes come clear of the panel support, and then lifting the board from the edge connector.

4.7 ACCESS TO AMPLIFIER BUFFER

The high impedance input buffer is contained under a metal screen near the input socket. Should it be necessary to remove this screen the procedure is as follows :-

(1) Turn off the instrument.

(2) Remove the display board.

(3) Remove the retaining screw at the top-front end of the input bracket.

(4) Turn the instrument upside down and remove the two screws on the bottom of the input bracket and screen.

(5) Replace display board and switch on the instrument.

4.8 POWER SUPPLY LINKS

Inductors L1 and L2 between tags U, V and W, X below the mains switch, and the wire link between tags S and T can be removed to isolate the power supply from the counter circuit. Adjustment of the preset variable resistor R123 which sets 5.1 V should be carried out with these links in position, i.e., with a load on the power supply.

4.9 POWER SUPPLY ADJUSTMENT

If repairs have to be made to the power supply the 5.1 V line should be reset as follows :-

(1) Connect a digital voltmeter such as the Fluke 8000A set to d.c. volts, 10 mV resolution, to link S-T.

(2) Adjust R123 until the d.v.m. reads 5.11 V ±0.1 V.

4.10 AMPLIFIER ADJUSTMENT

The following procedure should be undertaken only if repairs have been carried out to the amplifier section.

(1) Select READOUT UNITS : MHz.

(2) Adjust R43 for a readout of .0000. Then reverse the rotation of R43 until the readout changes to .00000.

4.11 AGC ADJUSTMENT

(1) Apply an 8 mV r.m.s. sinewave signal at approximately 100 kHz to the counter input.

(2) Monitor the voltage at the junction of R46, D8 and R36 with a sensitive voltmeter such as the TF 2600 series switched to the 30 mV range and connected via a x10 probe.

(3) Turn R38 fully counter-clockwise. Then reverse the rotation of R38 until a small decrease in level is seen on the voltmeter.

4.12 SCHMITT TRIGGER ADJUSTMENT

If counting is erratic in the presence of noise, the hysteresis of the Schmitt trigger may be adjusted by selecting a new value of R48. Increasing the resistance will increase the hysteresis.

Chapter 6

Replaceable parts

Introduction

Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification in the sequence A0 to A11.

The complete component reference carries its unit number as a prefix e.g. A1C1 but for convenience in the text and on circuit diagrams the prefix is not used.

However, when ordering replacements or in correspondence the complete component reference must be quoted.

The components are listed in alphanumerical order of the complete circuit reference and the following abbreviations are used :

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
Cerm	:	cermet
D	:	semiconductor diode
Elec	:	electrolytic
FS	:	fuse
IC	:	integrated circuit (package)
L	:	inductor
Max	:	maximum
ME	:	meter
Met	:	metal
Mic	:	mica
Min	:	minimum value
Ox	:	oxide
PL	:	plug
Plas	:	plastic dielectric
R	:	resistor
REG	:	regulator
S	:	switch
SK	:	socket
T	:	transformer
Tant	:	tantalum
TP	:	terminal
TR	:	transistor
Var	:	variable
WW	:	wirewound
XL	:	crystal
†	:	value selected during test; nominal value listed
Ø	:	feed-through component
W	:	watts at 70°C
⚠	:	static sensitive component

NOTE : One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons :

(a) Components indicated by a † have their value selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

(1) Type* and serial number of instrument

(2) Complete circuit reference

(3) Description

(4) MI code number

*As given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

Circuit reference	Description	M.I. code
Unit A0 : Overall assembly		
FS1	250 mA	23411-055P
	Fuse holder	23416-191C
	Cover for fuse holder	37575-121B
IC15	MA 150A ⚠	28469-367H
L2	10μH	23642-555G
PL1	Mains plug/filter assembly	23423-150L
	Cover for mains plug/filter	37590-150P
REG1	Voltage regulator (5V) 7805	28461-707G
REG2	Voltage regulator 12V) 7812	28461-708V
SA	SUPPLY ON/OFF, d.p.d.t.	23462-353A
	Cover for SA	37590-177D
	Extension spindle for SA	37590-143S
SB	230V/110V, d.p.c.o.	23467-155G
	Cover (red) for SB	37573-145C
	Locking plate for SB	34444-116Y
T1	Mains transformer	43490-035R
	*Rubber cushion pad for T1	37490-263X

*Replace pad when replacing T1.

Circuit reference	Description	M.I. code
Unit A1 : Function board		
	Complete board	44827-502N
C1	Plas 0.1μF 10% 100V	26582-799N
C2	Tant 0.47μF 20% 35V	26486-207L
C3	Cer 0.047μF -20+80% 25V	26383-017U
C4	Cer 0.047μF -20+80% 25V	26383-017U
C5	Elec 10μF -10+100% 63V	26423-215K
C6	Cer 0.047μF -20+80% 25V	26383-017U
C7	Elec 10μF -20+100% 63V	26423-215K
C8	Cer 0.01μF -20+80% 100V	26383-055L
C9	Plas 0.47μF 10% 63V	26582-410P
C10	Cer 4.7pF 5% 50V	26343-461B
C11	Elec 100μF -20+100% 16V	26423-242X
C12	Cer 0.047μF -20+80% 25V	26383-017U
C13	Elec 10μF -20+100% 63V	26423-215K
C14	Tant 2.2μF 20% 20V	26486-540K
C15	Cer 68pF 2% 50V	26343-475F
C16	Cer 0.01μF -20+80% 100V	26383-055L
C17	Cer 68pF 2% 50V	26343-475F
C18	Elec 47μF -20+100% 40V	26423-232G
C19	Elec 10μF -20+100% 63V	26423-215K
C20	Cer 0.001μF -20+80% 500V	26383-242P
C21	Cer 0.001μF -20+80% 500V	26383-242P
C22	Cer 0.001μF -20+80% 500V	26383-242P
C23	Tant 6.8μF 20% 6V	26486-560W
C24	Plas 0.1μF 10% 100V	26582-799N
C25	Cer 0.001μF -20+80% 500V	26383-242P
C26	Cer 0.001μF -20+80% 500V	26383-242P
C27	Cer 0.001μF -20+80% 500V	26383-242P
C28	Cer 0.001μF -20+80% 500V	26383-242P
C29	Cer 0.001μF -20+80% 500V	26383-242P
C30	Cer 0.001μF -20+80% 500V	26383-242P
C31	Cer 0.001μF -20+80% 500V	26383-242P
C32	Cer 0.001μF -20+80% 500V	26383-242P
C33	Cer 0.047μF -20+80% 25V	26383-017U
C34	Cer 0.01μF -20+80% 100V	26383-055L
C35	Cer 0.047μF -20+80% 25V	26383-017U
C36	Cer 0.047μF -20+80% 25V	26415-017U
C37	Elec 1000μF -20+100% 16V	26415-825W
C38	Cer 0.047μF -20+80% 25V	26383-017U
C39	Cer 0.047μF -20+80% 25V	26383-017U
C40	Elec 1000μF -20+100% 16V	26415-825W

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C41	Elec 470μF -20+100% 40V	26415-823V
C42	Elec 470μF -20+100% 40V	26415-823V
C43	Elec 470μF -20+100% 16V	26423-262J
C44	Elec 470μF -20+100% 40V	26415-823V
C45	Elec 100μF -20+100% 16V	26423-242X
C46	Cer 0.047μF -20+80% 25V	26383-017U
C47	Cer 0.047μF -20+80% 25V	26383-017U
C48	Cer 0.047μF -20+80% 25V	26383-017U
C49	Cer 0.047μF -20+80% 25V	26383-017U
C50	Cer 0.047μF -20+80% 25V	26383-017U
C51	Cer 0.047μF -20+80% 25V	26383-017U
C52	Cer 0.047μF -20+80% 25V	26383-017U
C53	Cer 0.047μF -20+80% 25V	26383-017U
C54	Cer 0.047μF -20+80% 25V	26383-017U
C55	Cer 0.047μF -20+80% 25V	26383-017U
C56	Cer 0.047μF -20+80% 25V	26383-017U
C57	Cer 0.047μF -20+80% 25V	26383-017U
C58	Cer 0.047μF -20+80% 25V	26383-017U
C59	Cer 0.047μF -20+80% 25V	26383-017U
C60	Cer 0.047μF -20+80% 25V	26383-017U
C61	Cer 0.047μF -20+80% 25V	26383-017U
C62	Cer 0.047μF -20+80% 25V	26383-017U
C64	Elec 100μF -20+100% 16V	26423-242X
C65	Elec 100μF -20+100% 16V	26423-242X
C66	Cer 15pF 2.5% 750V	26324-712S
C67	Cer 0.047μF -20+80% 25V	26383-017U
C68	Cer 0.047μF -20+80% 25V	26383-017U
C69	Cer 0.047μF -20+80% 25V	26383-017U
D1	1N4148	28336-676J
D2	Z5B 3.0	28371-203G
D3	1N4148	28336-676J
D4	Z5B 3.0	28371-203G
D5	Z5B 4.3	28371-313T
D6	MBD102	28349-004A
D7	MBD102	28349-004A
D8	BAY72	28337-126P
D9	BAY72	28337-126P
D10	1N41481	28336-676J
D11	1N4148	28336-676J
D12	1N4148	28336-676J
D13	1N4148	28336-676J
D14	BAY72	28337-126P
D15	1N4148	28336-676J
D16	1N4148	28336-676J
D17	Z5B 13.0	28372-213U
D18	1N4148	28336-676J
D19	1N4004	28357-028K
D20	1N4004	28357-028K
D21	1N4004	28357-028K
D22	1N4004	28357-028K
D23	1N4004	28357-028K
D24	1N4004	28357-028K
D25	1N4004	28357-028K
D26	1N4004	28357-028K
D27	1N4004	28357-028K
D28	1N4004	28357-028K
D29	1N4004	28357-028K
D30	1N4004	28357-028K
D31	Z5B 5.1	28371-403N
D32	1N825	28371-494Z
IC1	μA741	28461-304T
IC2	μA741	28461-304T
IC3	MC10105P	28466-105Z
IC4	MC10231P	28462-610K
IC5	MC10131P	28462-605R
IC6	74196	28464-004Y
IC7	7472	28462-003L
IC8	74S74	28462-607K
109	74123	28468-302D
IC10	74121	28468-402S
IC11	74132	28469-202E

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code	Circuit reference	Description	M.I. code
IC12	7490	28464-002E	R28	Met film 33Ω 2% ¼W	24773-237K
IC13	7403	28466-322J	R29	Met film 10kΩ 2% ¼W	24773-297M
IC14	74145	28465-018E	R30	Met film 10Ω 2% ¼W	24773-225W
			R31	Met film 10kΩ 2% ¼W	24773-297M
IC16	7404	28469-156B	R32 †	Met film 39Ω 2% ¼W	24773-239Z
			R33	Met film 220Ω 2% ¼W	24773-257W
			R34	Met film 10Ω 2% ¼W	24773-225W
R1	Carb 1MΩ 5% 1/8W	24311-945Y	R35	Met film 100kΩ 2% ¼W	24773-321L
R2	Carb 10MΩ 10% 1/8W	24321-885W	R36	Met film 100kΩ 2% ¼W	24773-321L
R3	Met film 4.7kΩ 2% ¼W	24773-289W	R37	Met film 22kΩ 2% ¼W	24773-305R
R4	Met film 220kΩ 2% ¼W	24773-329T	R38	Var cermet 10kΩ 10% ½W	25711-543D
R5	Met film 4.7kΩ 2% ¼W	24773-289W	R39	Met film 10kΩ 2% ¼W	24773-297M
R6	Met film 10Ω 2% ¼W	24773-225W	R40	Met film 100Ω 2% ¼W	24773-249J
R7	Met film 820Ω 2% ¼W	24773-271B	R41	Met film 1.2kΩ 2% ¼W	24773-275H
R8	Met film 22kΩ 2% ¼W	24773-305R	R42	Met film 3.3kΩ 2% ¼W	24773-285F
R9	Met film 4.7kΩ 2% ¼W	24773-289W	R43	Var cermet 10kΩ 10% ½W	25711-543D
R10	Met film 10kΩ 2% ¼W	24773-297M	R44	Met film 360Ω 2% ¼W	24773-262T
R11	Met film 33Ω 2% ¼W	24773-237K	R45	Met film 680Ω 2% ¼W	24773-269K
R12	Met film 220Ω 2% ¼W	24773-257W	R46	Met film 220Ω 2% ¼W	24773-257W
R13	Met film 10Ω 2% ¼W	24773-225W	R47	Met film 240Ω 2% ¼W	24773-258D
R14	Met film 680Ω 2% ¼W	24773-269K	R48 †	Met film 47Ω 2% ¼W	**24773-241A**
R15	Met film 10Ω 2% ¼W	24773-225W	R49	Met film 100Ω 2% ¼W	24773-249J
R16	Carb 2.2MΩ 10% 1/8W	24321-877J	R50	Met film 510Ω 2% ¼W	24773-266C
R17	Met film 1.2kΩ 2% ¼W	24773-275H	R51	Met film 510Ω 2% ¼W	24773-266C
R18	Met film 220Ω 2% ¼W	24773-257W	R52	Met film 47Ω 2% ¼W	24773-241A
R19	Met film 10Ω 2% ¼W	24773-225W	R53	Met film 10Ω 2% ¼W	24773-225W
R20	Met film 100Ω 2% ¼W	24773-249J	R54	Met film 22kΩ 2% ¼W	24773-305R
R21	Met film 27Ω 2% ¼W	24773-235R	R55	Met film 150Ω 2% ¼W	24773-253F
R22	Met film 240Ω 2% ¼W	24773-258D	R56	Met film 200Ω 2% ¼W	24773-256S
R23	Met film 33Ω 2% ¼W	24773-237K	R57	Met film 22kΩ 2% ¼W	24773-305R
R24	Met film 4.7kΩ 2% ¼W	24773-289W	R58	Met film 510Ω 2% ¼W	24773-266C
R25	Met film 220kΩ 2% ¼W	24773-329T	R59	Met film 330Ω 2% ¼W	24773-261D
R26	Met film 10Ω 2% ¼W	24773-225W	R60	Met film 22kΩ 2% ¼W	24773-305R
R27	Met film 1.2kΩ 2% ¼W	24773-275H	R61	Met film 680Ω 2% ¼W	24773-269K

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code	Circuit reference	Description	M.I. code
R62	Met film 510Ω 2% ¼W	24773-266C	R97	Met film 3.3kΩ 2% ¼W	24773-285F
R63	Met film 510Ω 2% ¼W	24773-266C	R98	Met film 3.3kΩ 2% ¼W	24773-285F
R64	Met film 2.2kΩ 2% ¼W	24773-281Y	R99	Met film 3.3kΩ 2% ¼W	24773-285F
R65	Met film 510Ω 2% ¼W	24773-266C	R100	Met film 3.3kΩ 2% ¼W	24773-285F
R66	Met film 2.2kΩ 2% ¼W	24773-281Y	R101	Met film 3.3kΩ 2% ¼W	24773-285F
R67	Met film 510Ω 2% ¼W	24773-266C	R102	Met film 330Ω 2% ¼W	24773-261D
R68	Met film 2.2kΩ 2% ¼W	24773-281Y	R103	Met film 330Ω 2% ¼W	24773-261D
R69	Met film 510Ω 2% ¼W	24773-266C	R104	Met film 330Ω 2% ¼W	24773-261D
R70	Met film 2.2kΩ 2% ¼W	24773-281Y	R105	Met film 330Ω 2% ¼W	24773-261D
R71	Met film 510Ω 2% ¼W	24773-266C	R106	Met film 330Ω 2% ¼W	24773-261D
R72	Met film 2.2kΩ 2% ¼W	24773-281Y	R107	Met film 330Ω 2% ¼W	24773-261D
R73	Met film 510Ω 2% ¼W	24773-266C	R108	Met film 330Ω 2% ¼W	24773-261D
R74	Met film 2.2kΩ 2% ¼W	24773-281Y	R109	Met film 330Ω 2% ¼W	24773-261D
R75	Met film 510Ω 2% ¼W	24773-266C	R110	Met film 3.3kΩ 2% ¼W	24773-285F
R76	Met film 2.2kΩ 2% ¼W	24773-281Y	R111	Met film 330Ω 2% ¼W	24773-261D
R77	Met film 510Ω 2% ¼W	24773-266C	R112	Met film 4.7kΩ 2% ¼W	24773-289W
R78	Met film 2.2kΩ 2% ¼W	24773-281Y	R113	Met film 3.3kΩ 2% ¼W	24773-285F
R79	Met film 510Ω 2% ¼W	24773-266C	R114	Met film 4.7kΩ 2% ¼W	24773-289W
R80	Met film 10Ω 2% ¼W	24773-225W	R115	Met film 330Ω 2% ¼W	24773-261D
R81	Met film 10Ω 2% ¼W	24773-225W	R116	Met film 4.7kΩ 2% ¼W	24773-289W
R82	Met film 120Ω 2% ¼W	24773-251L	R117	Met film 3.3kΩ 2% ¼W	24773-285F
R83	Met film 2.2kΩ 2% ¼W	24773-281Y	R118	Met film 330Ω 2% ¼W	24773-261D
R84	Met film 330Ω 2% ¼W	24773-261D	R119	Met film 330Ω 2% ¼W	24773-261D
R85	Met film 510Ω 2% ¼W	24773-266C	R120	Met film 3.3kΩ 2% ¼W	24773-285F
R86	Met film 1.5kΩ 2% ¼W	24773-277U	R121	Met film 1kΩ 2% ¼W	24773-273A
R87	Met film 330Ω 2% ¼W	24773-261D	R122	Met film 10kΩ 2% ¼W	24773-297M
R88	Met film 4.7kΩ 2% ¼W	24773-289W	R123	Var cermet 100Ω 10% ½W	25711-545P
R89	Var cermet 10kΩ 10% 0.3W	25748-507X	R124	WW 100Ω 5% 1½W	25123-050L
R90	Met film 1kΩ 2% ¼W	24773-273A	R125	Met film 2.2kΩ 2% ¼W	24773-281Y
R91	Met film 3.3kΩ 2% ¼W	24773-285F	R126	Met film 750Ω 2% ¼W	24773-270R
R92	Met film 47Ω 2% ¼W	24773-241A	R127	Met film 100Ω 2% ¼W	24773-249J
R93	Met film 1kΩ 2% ¼W	24773-273A	R130	Met film 510Ω 2% ¼W	24773-266C
R94	Met film 3.3kΩ 2% ¼W	24773-285F	R131	Met film 220kΩ 2% ¼W	24773-329T
R95	Met film 3.3kΩ 2% ¼W	24773-285F	R132	Met film 27Ω 2% ¼W	24773-235R
R96	Met film 3.3kΩ 2% ¼W	24773-285F	R133	Met film 1kΩ 2% ¼W	24773-273A

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
SA, SB, SC, SD	Push button switch assembly	44338-053Y
SE	INT/EXT, d.p.c.o.	23467-155G
SKA	INPUT, 50Ω BNC receptacle	23443-406R
SKB	EXT.IN. 50Ω BNC receptacle	23443-446H
SKC	INT.OUT. 50Ω BNC receptacle	23443-446H
SKD	Edge connector, 20-way	23435-056W
TR1	40673 ⚠	28459-010V
TR2	BSX20	28452-197H
TR3	2N5179	28451-697Y
TR5	2N5179	28451-697Y
TR6	2N5179	28451-697Y
TR7	2N5179	28451-697Y
TR8	2N5179	28451-697Y
TR9	MPSL08	28431-767E
TR10	2N5179	28451-697Y
TR11	2N5179	28451-697Y
TR12	2N5179	28451-697Y
TR13	BC308B	28433-455R
TR14	BC308B	28433-455R
TR15	BC308B	28433-455R
TR16	BC308B	28433-455R
TR17	MPSL08	28431-767E
TR18	2N5179	28451-697Y
TR19	BC238B	28452-781A
TR20	2N5448	28433-838Z
TR21	2N5448	28433-838Z
TR22	2N5448	28433-838Z
TR23	2N5448	28433-838Z
TR24	2N5448	28433-838Z
TR25	2N5448	28433-838Z
TR26	2N5448	28433-838Z
TR27	2N5448	28433-838Z
TR28	BC238B	28452-781A
TR29	BC238B	28452-781A
TR30	BC238B	28452-781A
TR31	BC238B	28452-781A
TR32	MM4001	28438-436Y
TR33	BC308B	28433-455R
	Heat sink for TR32	28488-448H

Unit A2 : Display board

	Complete board	44827-499F
C1	Cer 0.047μF -20+80% 25V	26383-017U
IC1	SN7447	28465-005P
LP1	LED, red, FLV140	28624-109M
LP2	LED, red, FLV140	28624-109M
LP3	LED, red, FLV140	28624-109M
LP4	LED, red, FLV140	28624-109M
R1	Met film 47Ω 2% ¼W	24773-241A
R2	Met film 47Ω 2% ¼W	24773-241A
R3	Met film 47Ω 2% ¼W	24773-241A
R4	Met film 47Ω 2% ¼W	24773-241A
R5	Met film 47Ω 2% ¼W	24773-241A
R6	Met film 47Ω 2% ¼W	24773-241A
R7	Met film 47Ω 2% ¼W	24773-241A

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
Unit A10 : Oscillator board		
	-for use with Version 52431-301Y -	
	Complete board	44827-563E
C1 †	Cer 22pF 5% 50V	26343-469N
C2	Var cer 4.5pF -15pF	26847-115H
C3	Cer 100pF 2% 50V	26343-477V
C4	Cer 220pF 2% 50V	26343-481S
C5	Cer 0.01μF -20+80% 100V	26383-055L
C6	Cer 0.01μF -20+80% 100V	26383-055L
D1	BB142	28381-097W
R1	Met film 47kΩ 2% ¼W	24773-313H
R2	Met film 47kΩ 2% ¼W	24773-313H
R3	Met film 2.2kΩ 2% ¼W	24773-281Y
R4	Met film 2.2kΩ 2% ¼W	24773-281Y
R5	Met film 68kΩ 2% ¼W	24773-317N
R6	Met film 680Ω 2% ¼W	24773-269K
R7	Met film 100kΩ 2% ¼W	24773-321L
TR1	BC238B	28452-781A
TR2	BC238B	28452-781A
XL1	10 MHz AT cut	28312-047U

Circuit reference	Description	M.I. code
C4	Cer 220pF 2% 50V	26343-481S
C5	Cer 220pF 2% 50V	26343-481S
C6	Cer 0.0047μF -20+80% 100V	26383-321K
C7	Cer 0.0047μF -20+80% 100V	26383-321K
D1	BB142	28381-097W
IC1	μA741C	28461-313B
R1	Met film 22kΩ 2% ¼W	24773-305R
R2	Met film 22kΩ 2% ¼W	24773-305R
R3	Met film 2.2kΩ 2% ¼W	24773-281Y
R4	Met film 2.2kΩ 2% ¼W	24773-281Y
R5	Met film 68kΩ 2% ¼W	24773-317N
R6	Met film 510Ω 2% ¼W	24773-266C
R7	Met film 1.5Ω 2% ¼W	24773-205K
R8	Carb 47kΩ 5% 1/8W	24331-982F
R9	Carb 47kΩ 5% 1/8W	24331-982F
R10	Carb 2.2kΩ 5% 1/8W	24331-983G
R11	Carb 2.2kΩ 5% 1/8W	24331-983G
R12	Carb 68kΩ 5% 1/8W	24331-981J
R13	Carb 680Ω 5% 1/8W	24331-984V
R14	Carb 100kΩ 5% 1/8W	24331-980L

Unit A11 - Oscillator board (high stability)		
	- for use with Version 52431-302N -	
	Complete board	44990-147D
C1	Cer 0.0047μF -20+80% 100V	26383-321K
C2	Var cer 6pF - 22pF	26847-093S
C3	Cer 22pF 5% 50V	26343-469N
TR1	BC308	28433-455R
TR2	2N4918	28434-896Y
TR3	BC238B	28452-780K
TR4	BC238B	28452-780K
XL1	10 MHz	28312-043A

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
	Miscellaneous mechanical parts	
	Wrap-round case	35901-587A
	Case base plate (less handle assembly)	35901-586K
	Aperture plate for rear panel	35901-572V
	Edging surround for case (1 of 2)	37590-117M
	Tilt handle	37587-925L
	Handle attachment	37588-110B
	Case foot (1 of 2)	22315-663B
	Earthing contact on side frame (1 of 2)	31559-005X
	Buttress moulding, red, support-ind display board (1 of 2)	37590-141G

Circuit reference	Description	M.I. code
	Accessories	
	Mains lead, with straight 3-way socket	43123-076Y
	Mains lead, with angled 3-way socket	43129-163L
	Coaxial lead, with BNC plugs	43126-013W
	Stowage lid for front panel, complete with clips	41690-158L
	Retaining cover for stowage lid	35901-684M
	Fixing stud for cover (1 of 2)	21186-365V
	Rubber washer for fixing stud (1 of 2)	21186-362J
	Rear stand	35901-686R
	Hand strap	22315-578S
	Shoulder strap	22315-577V

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

CIRCUIT NOTES

1. COMPONENT VALUES

Resistors : No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.
Inductors : No suffix = henries, m = millihenries, μ = microhenries.
SIC : value selected during test; nominal value shown.

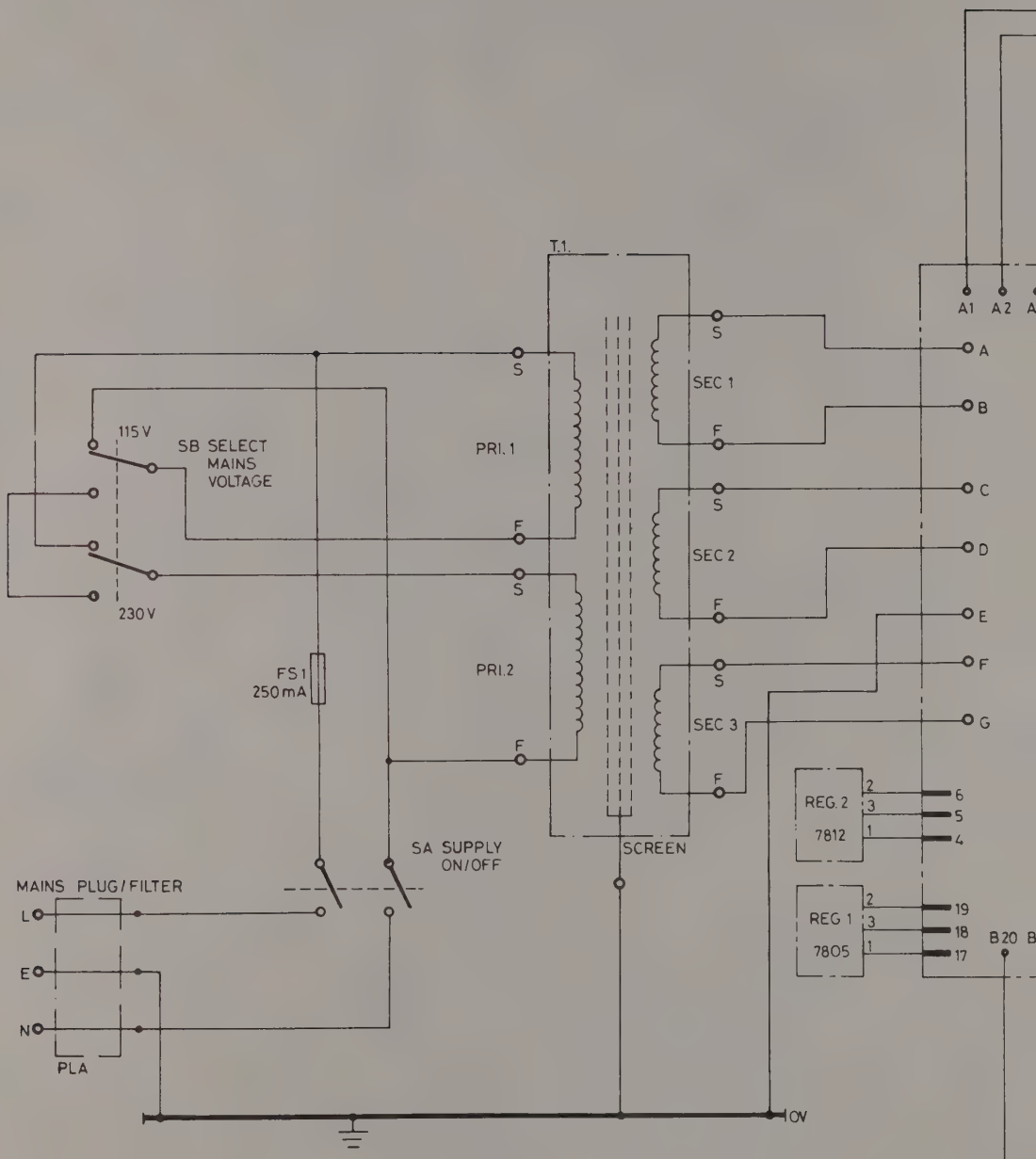
2. VOLTAGES

Voltages are d.c. and relative to chassis unless otherwise indicated. Measured with 20 kΩ/V meter.

3. SYMBOLS

Generally in accordance with BS3939.

⚠ see CAUTION notes in Sects. 2.2 and 4.1.



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INTERCONNECTION

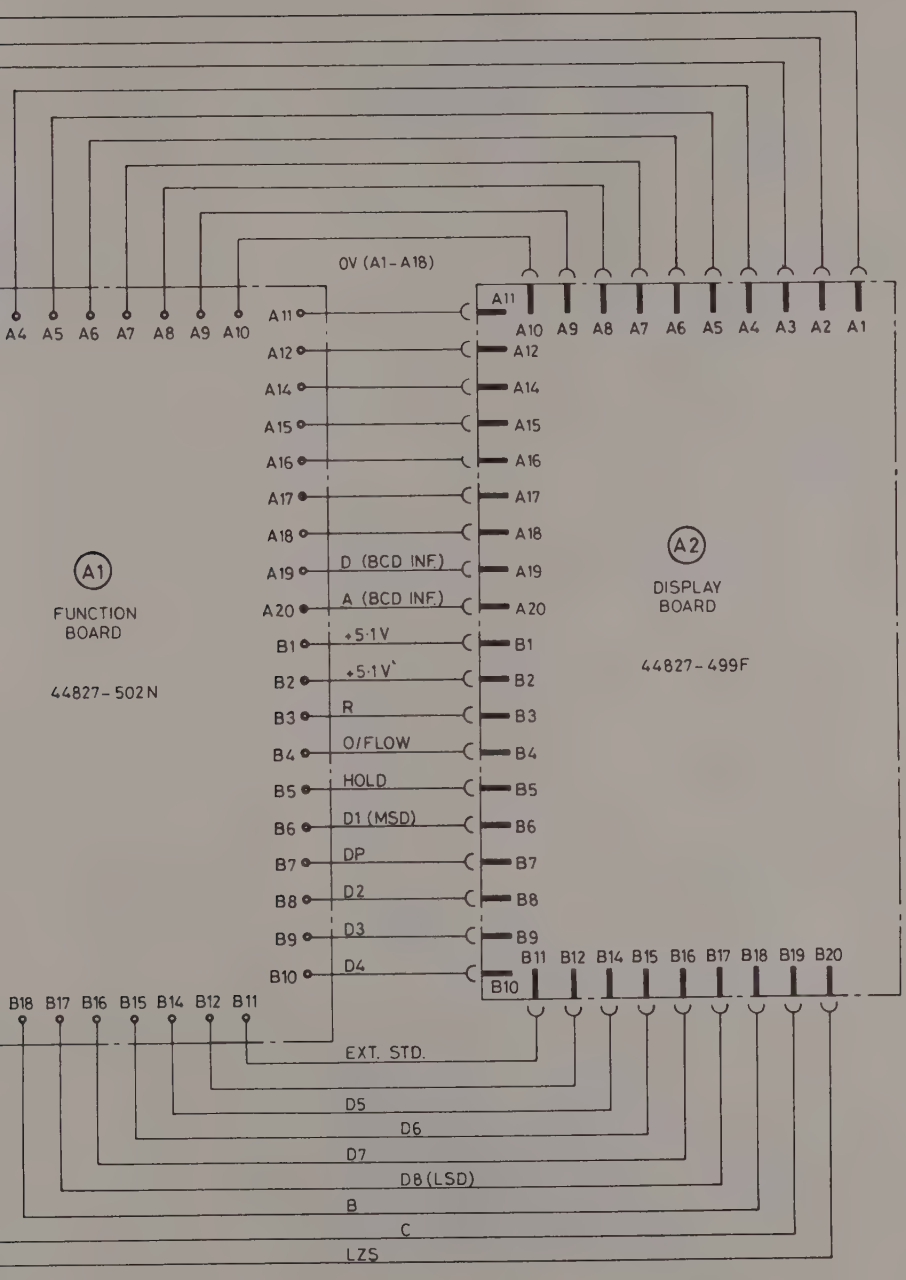
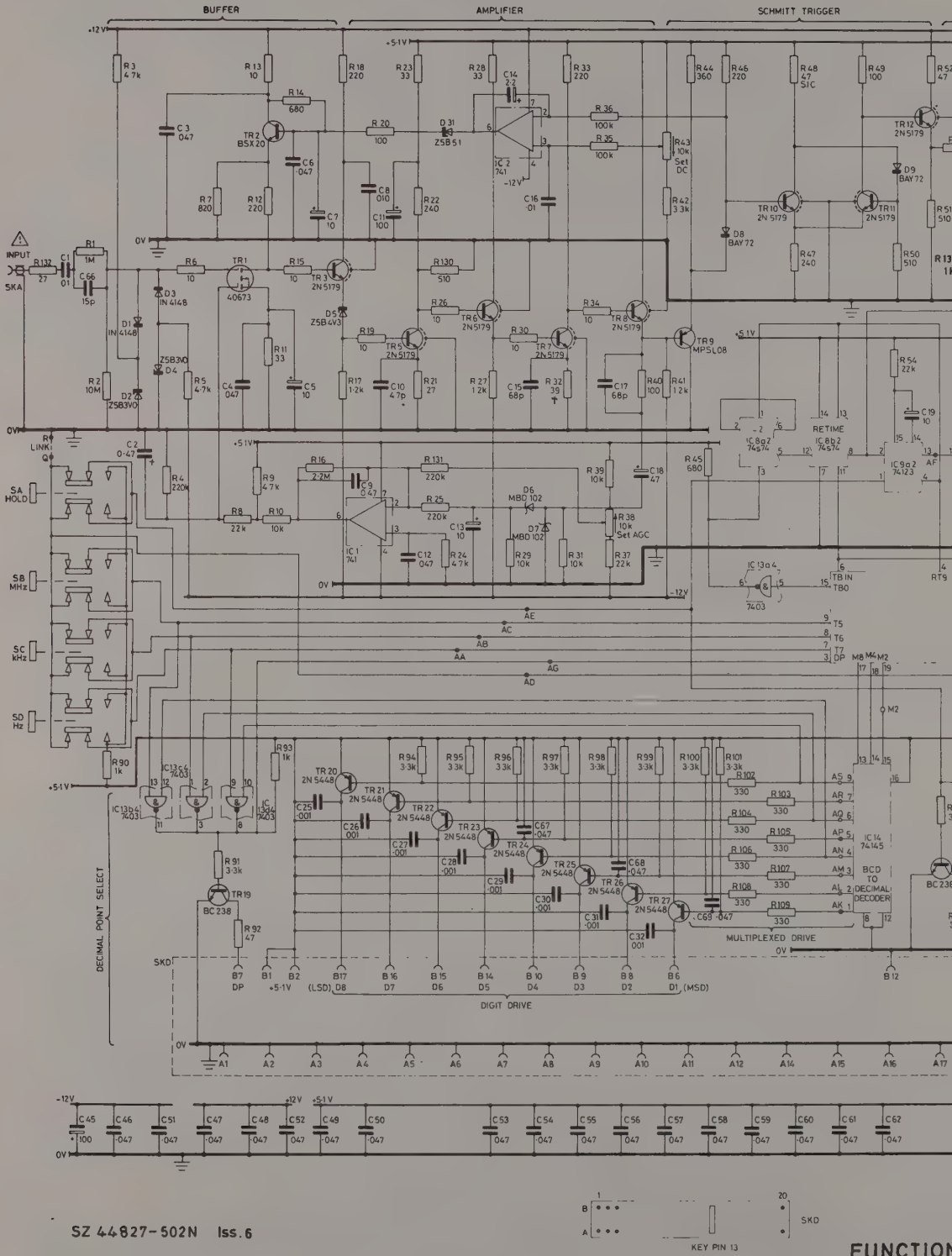


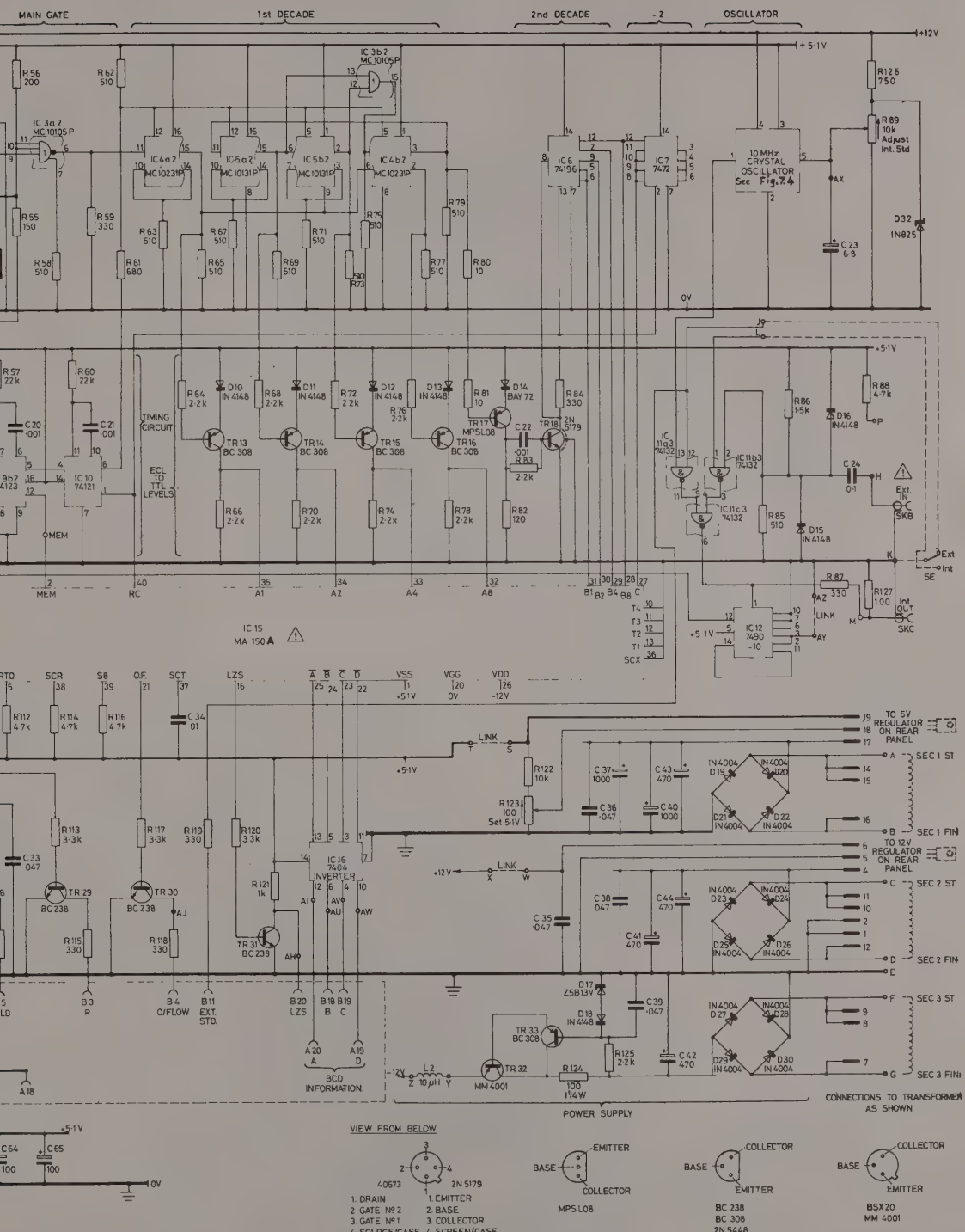
DIAGRAM : A0

Fig. 7.1



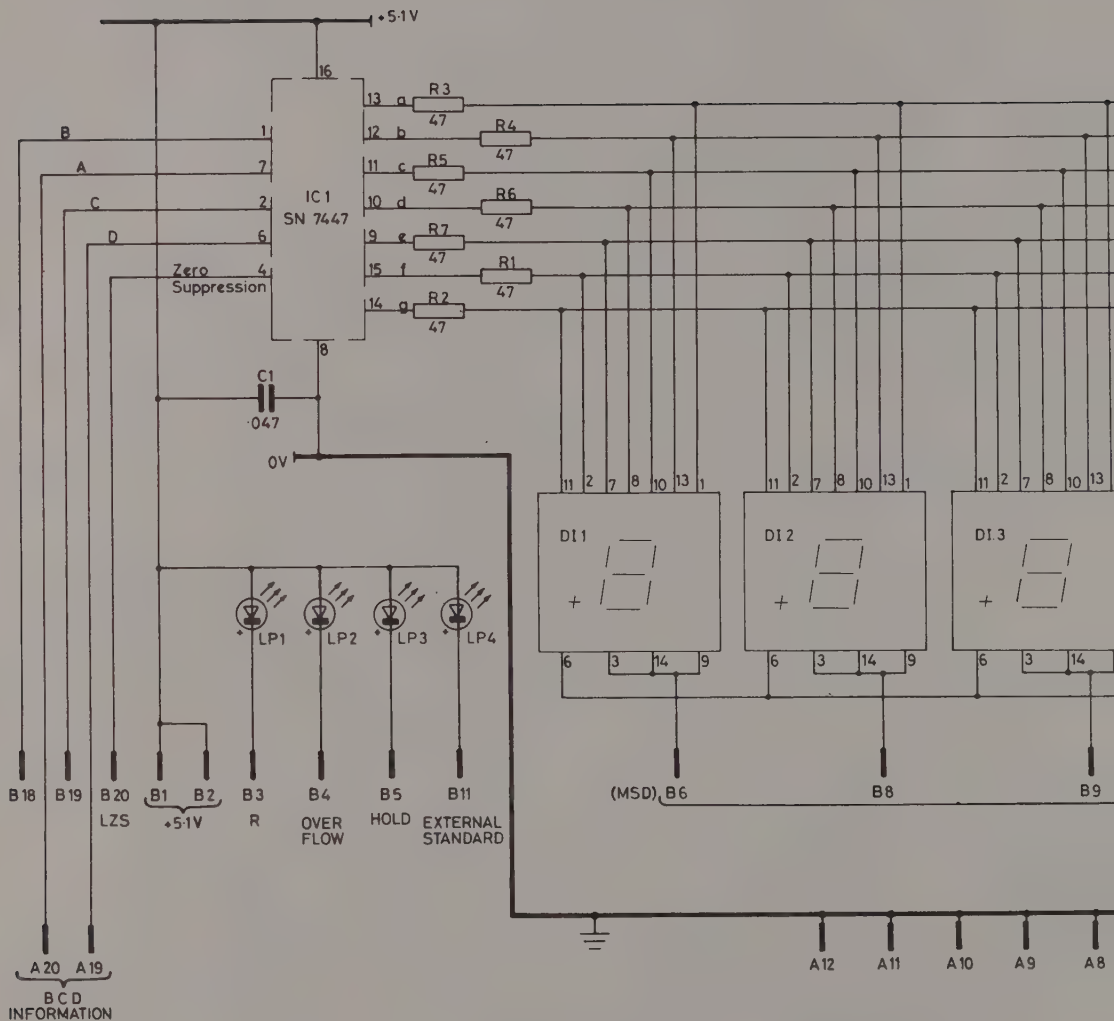
SZ 44827-502N Iss.6

FUNCTION



BOARD : A1

Fig. 7.2



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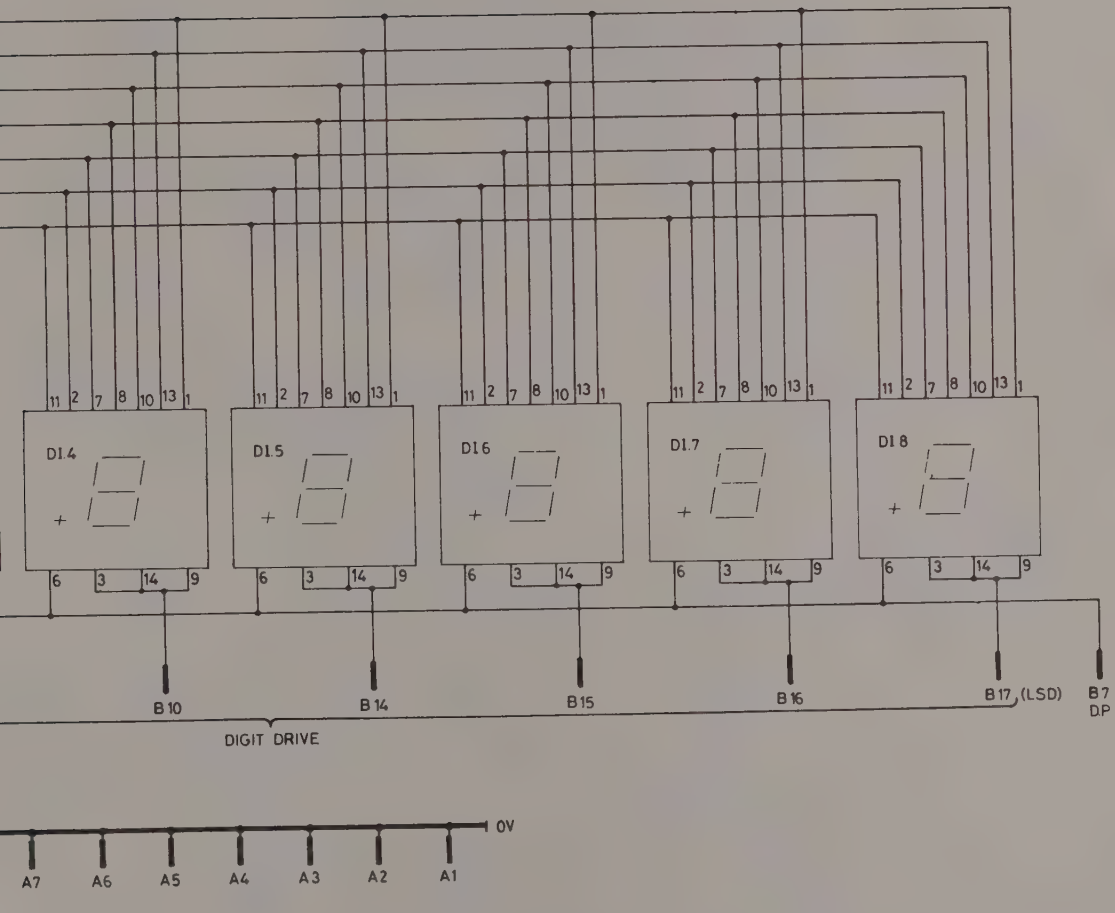
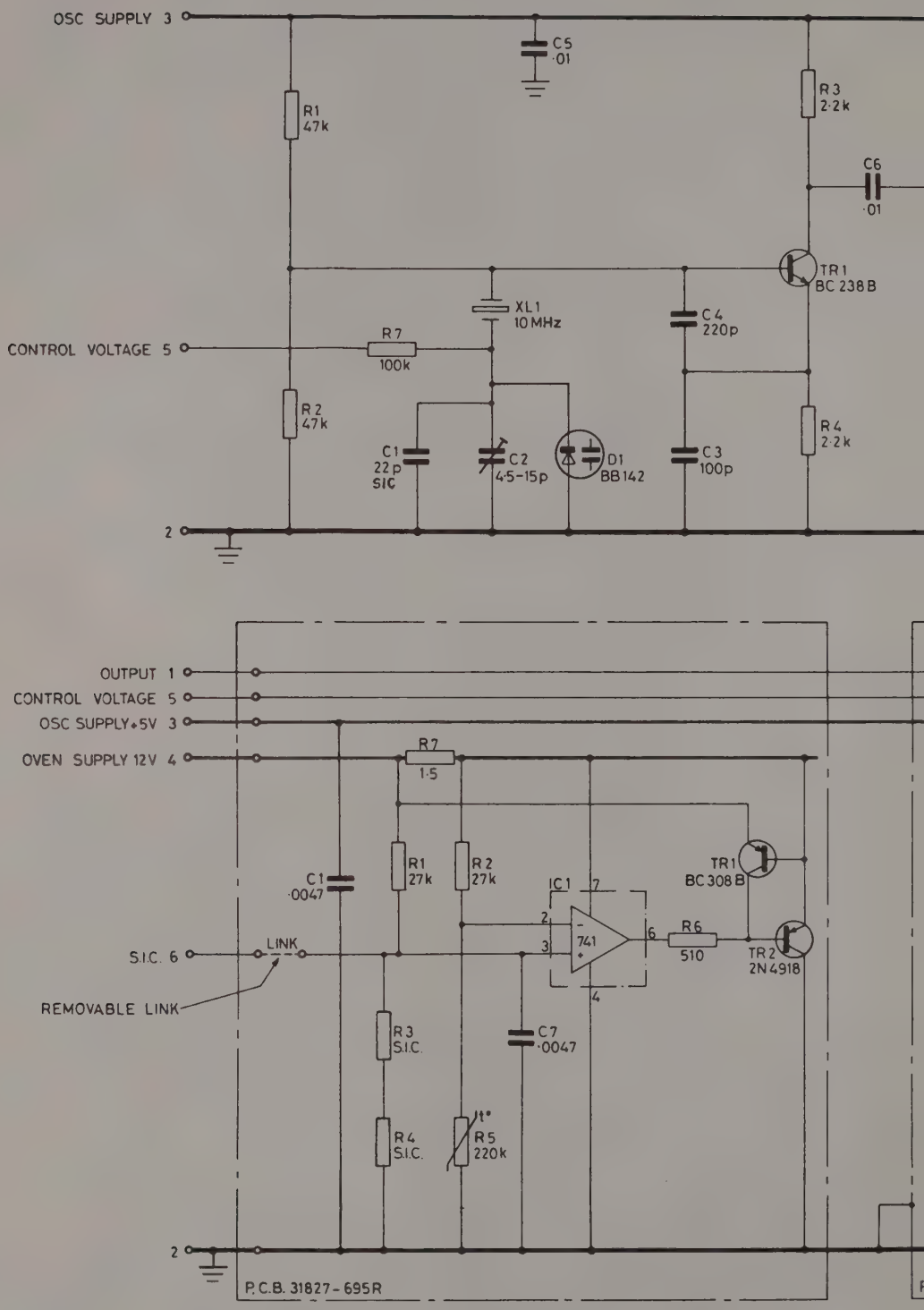
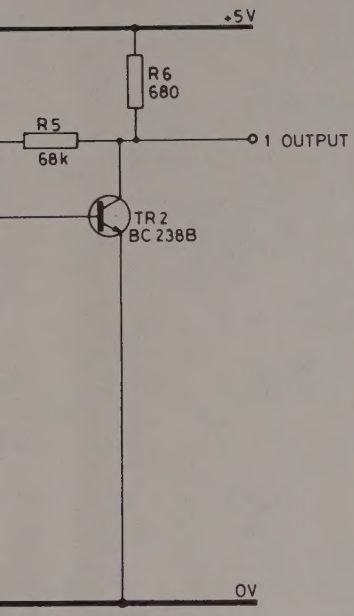


BOARD : A2

Fig. 7.3



10MHz OSCILLA



A10

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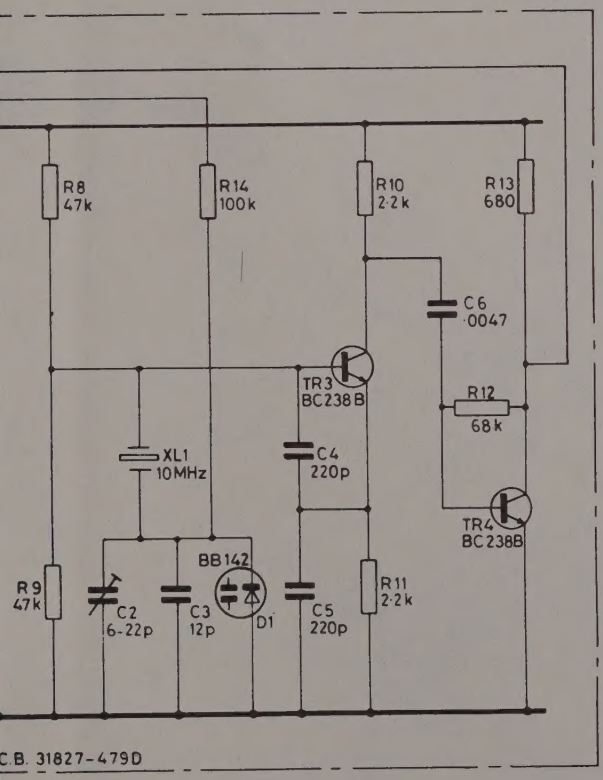
Iss.3



A11

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Fig.7.4

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